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MASSIVE TROILITE FROM DEL NORTE COUNTY, CALIFORNIA[1]

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OCCURRENCE:—A few specimens of an iron sulfide, supposed to be pyrrhotite because of its bronze brown tarnished surfaces, were brought to me by Mr. Vonsen, who had obtained them from the owner of a copper claim in the northern part of Del Norte County. The specimens showed some properties quite distinct from those for pyrrhotite and the analysis of the mineral proved it to be the monosulfide of iron, FeS. This ferrous sulfide has been observed in nature only as a constituent of meteoric iron and is known as troilite. Its properties have not been determined sufficiently to differentiate it from pyrrhotite, so the Del Norte troilite is an important discovery, not alone on account of its terrestrial origin but also because of its abundance. It agrees with the troilite of the Cañon Diablo meteorite in its properties, pieces of which were kindly given to me by Mr. Merrill, so the two are identical.

PROPERTIES:—The Del Norte mineral is distinct from pyrrhotite in several respects. The color is slightly different; it is non-magnetic and it is easily soluble in dilute sulfuric acid. The color of the untarnished mineral is light grayish brown with no bronze tinge. The powder is completely nonmagnetic when tested with a horse-shoe magnet. The magnetism of pyrrhotite varies in intensity, yet it is doubtful if a nonmagnetic variety really exists. It is always classed as a magnetic mineral. From the Del Norte mineral we can infer that the monosulfide is non-magnetic and that pyrrhotite with its excess sulfur is a distinctly different sulfide. In the description of troilite in Dana's System of Mineralogy no

[1] Paper read at the annual meeting of the Mineralogical Society of America, Amherst, Mass., December 29, 1921.

mention is made of its non-magnetic property. The most striking difference between troilite and pyrrhotite lies in their behavior with sulfuric acid. The acid immediately attacks troilite and generates hydrogen sulfide as copiously as it does with the commercial monosulfide of iron used for that purpose. Pyrrhotite remains inert in the acid and a trial of pieces from all the localities represented in our collection showed that not one of them was dissolved by the acid. It requires hydrochloric or nitric acid to dissolve pyrrhotite. This certainly indicates that a sulfide with a formula corresponding to Fe_nS_{n+1} is chemically and structurally different from one with a formula FeS.

ANALYSES: The iron could be determined easily by titration of the dilute sulfate solution. Several titrations of each sample were made. For the determination of the sulfur it was necessary to oxidize it by fusion with nitrate and carbonate of potassium or sodium. Nitric acid invariably liberated some sulfur and long boiling in the acid with additions of bromine or potassium chlorate failed to completely oxidize the small globules of free sulfur. The first sample was not carefully separated from its impurities which amounted to seven per cent. The second sample was hand picked and fairly pure.

Analyses:	I	Ratio	II	Ratio
Fe.............	58.78%	1.052	62.70	1.123
S..............	33.62	1.048	35.40	1.104

Both of these samples show a ratio Fe:S practically 1:1.

The mineral is therefore chemically as well as physically the monosulfide of iron, FeS. The total iron in the samples varied from 64% to 66% but no complete analyses of the inclusions were made, since the portion soluble in sulfuric acid was the troilite. The specific gravity of the second sample was 4.67.

INCLUSIONS:—Small particles and bunches of bluish black serpentine containing much iron occur sparsely disseminated in the massive troilite and it was difficult to completely eliminate them by hand picking. The dilute acid did not dissolve them so they did not affect the analyses of the soluble troilite. A small amount of carbon is also present, making the mineral similar in this respect to the meteoric troilite. A trace of copper, but no nickel or chromium occurs, although chromite was said to occur with the mineral.

The principal inclusion is magnetite. Its brilliant black color separates it distinctly from the troilite. It occurs in granular

patches, some showing minute octahedrons. Some of the rims show a gradation into the troilite and the magnetite appears to be residual patches left from a conversion of a larger mass into troilite.

ORIGIN:—The locality is remote and has not been visited by the writer and the description of the occurrence comes from the owner of the copper claim. He reports that the chalcopyrite bodies occur in a shear zone of serpentine along an extensive fault. This zone consists of fractured, slickensided, and altered rock which has evidently been impregnated by sulfide solutions which deposited the chalcopyrite. The troilite was found in one of the tunnels in rounded masses with smooth, somewhat slickensided surfaces. These were probably magnetite masses in the original serpentine and the solutions carrying hydrogen sulfide transposed them into the sulfide. The large amount of iron appears to have conditioned the formation of the monosulfide instead of the more common pyrrhotite with its excess of sulfur over the iron.

PYRRHOTITE:—Many analyses of pyrrhotite have been made but most of them are of the massive material, since crystals are rare. Doubtless there would be more agreement in the analyses if only pure crystals were analyzed, but as it is the variation is not wide. Sulfur is always in excess of the iron to correspond to a ratio of 1:1, and the analyses yield such formulas as Fe_5S_6, Fe_7S_8, $Fe_{11}S_{12}$, etc. The general formula used to express the composition is Fe_nS_{n+1}.

The theory of solid solutions of the elements in a mineral has been advanced to explain the variations in the composition of some of our massive minerals and this theory might be extended to pyrrhotite to explain the seeming excess of sulfur. Allen, Crenshaw, Johnston and Larsen[2] in their excellent paper on the mineral sulfides of iron, showed that synthetic pyrrhotite could be formed from pyrite or marcasite which would vary in the ratio of sulfur to iron in the same way as in the natural mineral. From their analyses of the ten synthetic sulfides they calculated that all sulfur in excess of a ratio Fe:S = 1:1 was sulfur in solid solution, basing their calculations on the assumption that FeS was the end member of their pyrrhotite series. Their statement that troilite is nothing more than pyrrhotite and has no right as a separate species or

[2] The Mineral Sulfides of Iron: E. T. Allen, J. L. Crenshaw and J. Johnston with crystallographic study by E. S. Larsen. *Amer. Jour. Sci.*, 33, 169–236, 1912.

name since it is only the end member of the series, does not conform to the facts. Troilite and pyrrhotite are too distinct in their properties to be considered in the same series. In some of our later textbooks the formula for pyrrhotite is stated as FeS. No analysis of pyrrhotite shows this to be the case; on the contrary all of the analyses conform to the generally accepted formula Fe_nS_{n+1}. The formula $Fe_{11}S_{12}$, which approximately agrees with the composition of most pyrrhotites, if considered as FeS+S in solid solution, contains 3.22% excess sulfur. It seems quite improbable that this small excess held as solid solution would convert non-magnetic, easily soluble troilite into magnetic, insoluble pyrrhotite. The magnetic property and general composition of pyrrhotite certainly indicate a chemical difference from the other iron sulfides and in fact, suggest an analogy to magnetite. The ferrous and ferric oxides alone are non-magnetic but in combination form a strongly magnetic compound. Pyrrhotite is considered wholly a ferrous sulfide while its magnetism suggests the presence of the ferric molecule and a formula such as Fe_3S_4 would still conform to the general formula Fe_nS_{n+1}. Carrying out this idea which is offered merely as a suggestion, Fe_3S_4 might be considered as an end member for pyrrhotite and variations in composition be ascribed to excess percentages of the ferrous sulfide, perhaps present as solid solution.

CERULEOFIBRITE, A NEW MINERAL[1]

EDW. F. HOLDEN, *University of Michigan*

Several specimens of cuprite, in the Mineralogical Museum of the University of Michigan, contained a blue, fibrous mineral which has proven to be a new species. The proposed name, ceruleofibrite, is from the Latin *caeruleus*, blue, and *fibra*, a fiber.

These specimens were purchased from the Foote Mineral Company, and were labelled from "Bisbee, Arizona." They are composed chiefly of cuprite, containing disseminated flakes of copper, associated with azurite, chrysocolla, and small crystals of brochantite. Another specimen, obtained from Ward's Natural Science Establishment which was in reality ceruleofibrite, was labelled "conellite on cuprite," the locality being given as Lowell, which is in the Bisbee district.

[1] Paper read at the annual meeting of the Mineralogical Society of America, Amherst, Mass., December 29, 1921.

The ceruleofibrite occurs in tufts of very narrow radiating fibers in small cavities, or as compact masses with a fibrous structure, disseminated thru the cuprite. The individual fibers are of a pure bright blue color, and are transparent; the more compact masses have a somewhat blackish blue color. The streak is light blue, and the luster silky. The hardness is approximately 3; the specific gravity, as determined with the pycnometer, is 3.54.

Under the microscope the fragments appear as long needles, but at times sections across the fibers may be seen. The color of the fragments is light blue, and there is a very slight pleochroism to be noted. The extinction in all sections is parallel; the mineral being therefore orthorhombic. The indices of refraction, as determined by the immersion method, are, for sodium light, $\alpha = 1.736$, $\beta = 1.737$, $\gamma = 1.741$; all $\pm .002$; and $\gamma - \alpha = 0.005$. The mineral is positive, and the calculated value of $2V = 53°$. The orientation is $X = a$, $Y = b$, $Z = c$; the plane of the optic axes must accordingly be parallel to *b* (010), and $Bx_a = Z$. In those needles lying on the brachypinacoid face, a perfect cleavage at 32° with the elongation of the needles was observed.

Termination of ceruleofibrite crystal greatly magnified

The acicular crystals of ceruleofibrite average 3—4 mm. in length, and have a diameter of only a few hundredths of a millimeter. It was impossible to measure them on the goniometer, so the angles were approximately determined on the microscope, using a magnification of 430 diameters. By mounting the needles vertically on wax, and focusing on their terminations, it was possible to measure the angles between the faces of the prism zone. The outline of that zone was rectangular, with the pinacoid *b* (010) the largest face, its corners cut by the unit prism *m* (110), while the pinacoid *a* (100) was very small, tho most always present. Several of the needles showed a macrodome; this was taken to be *v* (101), and the cleavage at 32° with the elongation of needles lying on the brachypinacoid is parallel to this form. The axial ratios and measured angles of ceruleofibrite correspond very closely to those for brochantite, and indicate that the minerals are isogonic.

TABLE 1

	CERULEOFIBRITE	BROCHANTITE
Axial ratios	$a:b:c=0.78:1:0.49$	$a:b:c=0.7739:1:0.4871$
$100\wedge 110$	38°	37° 44′
$010\wedge 110$	52°	52° 16′
$110\wedge 1\bar{1}0$	76°	75° 28′
$110\wedge \bar{1}10$	104°	104° 32′
$101\wedge \bar{1}01$	64°	64° 22′

Ceruleofibrite dissolves readily in cold dilute HCl or hot dilute HNO_3, but is insoluble in water. The solutions react for copper and chlorine, and faintly for arsenic. An attempt to reduce a ferric chloride solution by means of a solution of absolutely pure ceruleofibrite failed, and showed all the copper of the mineral to be bivalent, tho the presence of admixed cuprite usually causes some reaction for cuprous copper. Heated in the closed tube the mineral becomes first green and finally black; it gives up water at a moderately high temperature, and a yellowish sublimate containing arsenic. The mineral gives an azure color to the flame.

A quantitative analysis was made: water being determined in an ignition tube; chlorine as silver chloride; copper was determined both volumetrically and gravimetrically; arsenic was precipitated as magnesium ammonium arsenate, and weighed as the pyroarsenate. Chlorine and copper were determined in duplicate, and gave close checks. The result of the analysis is given in the first column of table 2. The molecular ratios (second column) show the formula to be: $CuCl_2 . \frac{1}{3}\ Cu_3As_2O_8 .\ 6\ Cu(OH)_2$, which of course may be tripled. The theoretical composition for this formula is given in the third column. CuO in the analysis is high due to the presence of a very small amount of cuprite. Deducting the excess of this constituent and the material insoluble in acid, and recalculating to 100% gives the results in column 4, which agree very closely with the theoretical values.

TABLE 2

	1	2	3	4
CuO............	73.8	.927 8.3=8	72.7	72.7
Cl	7.5	.212 1.9=2	8.1	8.2
As_2O_5...........	7.5	.033 .3=⅓	8.7	8.2
H_2O............	11.7	.650 5.8=6	12.3	12.7
Insoluble........	0.3	....	....	....
Less O=Cl......	1.7		1.8	1.8
Sum............	99.1%		100.0%	100.0%

By doubling the formula of brochantite its composition is found to be somewhat analogous to that of ceruleofibrite:

Brochantite....................	$CuSO_4$.	$CuSO_4$.	$6\,Cu\,(OH)_2$
Ceruleofibrite..................	$CuCl_2$.	$Cu\frac{As_2O_3}{3}$.	$6\,Cu\,(OH)_2$

This accords with the isogonic relation noted above. The composition of this very basic copper chloroarsenate is unique in that in it one atom of copper is combined with arsenic acid to one with chlorine, while in the only other case of such a combination, the minerals of the apatite group, nine atoms of metal combine with arsenic (or phosphoric) acid to one with a halogen;

Ceruleofibrite..................	$CuCl_2$.	$Cu\,\frac{As_2O_3}{3}$	$6\,Cu\,(OH)_2$
Mimetite......................	$PbCl_2$.	$Pb_9\,(As_2O_8)_3$	

It is suggested that an examination of Bisbee cuprites in other collections might reveal more specimens of ceruleofibrite.

NOTES ON SAND CALCITE FROM SOUTH DAKOTA

Harold R. Wanless, *Princeton University*

It was the writer's privilege last summer to visit the Rattlesnake Butte locality in South Dakota where great quantities of sand calcite crystals may be obtained, and, as this locality would doubtless be very interesting to mineralogists who might be in the vicinity, some notes on it are presented here.

Rattlesnake Butte, or the Devil's Hill, is situated on the Pine Ridge Indian Reservation approximately 23 miles (37 km.) straight south of the town of Interior, Jackson County, S. D. This is on the Black Hills line of the Chicago, Milwaukee, and St. Paul Railway, about 80 miles east of Rapid City; Interior is also on the George Washington Highway. To reach the Rattlesnake Butte locality from Interior, one goes about one mile west on the Washington Highway, then south on a reservation road, crossing White River about two miles from town, then in general following the main travel, avoiding the first two right forks, and keeping to the right after they are passed for about 15 miles, then going through a gate where there are three forks, taking the middle branch. About a mile further one takes the right fork. This is near the top of a hill overlooking the valley of Bear in the Lodge Creek, and the Snake Butte Hills can be seen from here as a

low line of hills with irregular rough tops about 6 miles south. Continuing straight south about four miles, one comes to an east-west fence around a half section, and the main road turns east along it. When the fence is reached, one leaves the main road and follows a trail west along the fence to the end of the fence, then angles southwest over a hill for about 1½ miles, then leaving the road, turns left across an undulating grassy hill and the Snake Buttes are about ¼ mile distant. It is possible to drive right to the base of the buttes with a car. Further directions and conveyance can be procured from Mr. Campbell of the real estate

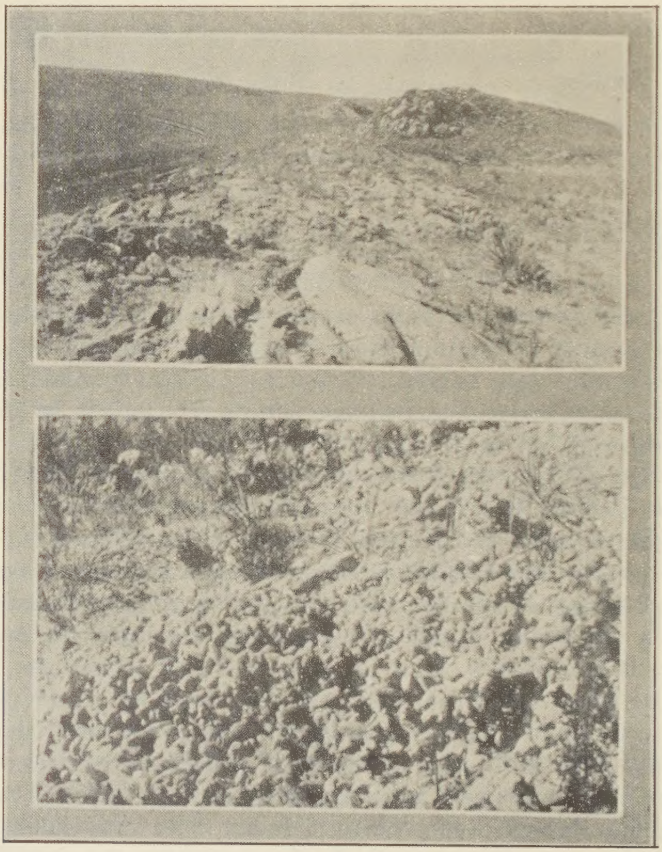

FIG. 1 (above): Sandstone capped ridge of Rattlesnake Butte.
FIG 2 (below): Mass of sand calcite crystals from Rattlesnake Butte, S. D.

firm of White and Campbell at Interior, who is familiar with the locality.

The ridges are capped by a bed of coarse sandstone about three to four feet thick, and especially at the southern end of the line of hills great masses of perfect scalenohedrons of sand calcite are found, also single crystals and radiating rosette-structure masses, also massive pipes in which the identity of the crystals is lost.

Analyses by Professor A. H. Phillips and the writer have found the per cent of calcite in the crystals to be 36.95–37.00%. This seems to be a constant proportion. Mud and silt are present to 0.2% and the sand studied mineralogically yielded quartz, orthoclase, microcline, albite, muscovite, biotite, hornblende, augite, green, black and colorless prisms of tourmaline, zircon, garnet, staurolite, magnetite, and an opaque polished mineral, perhaps cassiterite, but in too small grains to be tested chemically. Besides this, fragments of volcanic glass and two varieties of mica schist were found. Most of the grains are well rounded and many have a ground glass surface, indicating rounding by wind action. The hornblende and augite grains are generally ellipsoidal, or prisms with rounded edges, and the magnetite, zircon, and quartz are generally nearly spherical. The garnets show some crystal faces and the tourmalines are good prisms, not rounded.

Certain of the minerals present indicate derivation from pre-Cambrian pegmatites (tourmaline) and schists (garnet, staurolite, and schist fragments) of the Black Hills. The presence of wind-rounded volcanic ash is significant of the volcanic activity of the Cordilleran district of the early Tertiary.

The age of the sand calcite crystals is Lower Miocene in stratigraphic position, though they may have been formed at a later period by the action of ground water. They were very likely formed by spring deposition at normal temperatures, but under some pressure of overlying rock. Their sand is evidently derived from coarse wind-blown sand of a dune deposit. Sand dunes are now not rare in this district and have probably been locally present throughout the Tertiary. The absence of mud and silt and the perfect rounding of the grains with wind-etched surfaces point clearly to dune origin.

The method of analysis used to determine the minerals of the sands was as follows: (1) Treatment of a weighed sample with dilute HCl to dissolve out the calcite; the residue was weighed

and per cent of calcite determined. (2) Sample treated by decantation to remove mud and silt and again weighed. (3) Sand residue treated with Thoulet's solution (sp. gr. 2.95) and the heavy minerals were thus concentrated. (4) Magnetic treatment of the heavy residue separated out the magnetite. (5) The light and heavy concentrates were studied with the binocular and petrographic microscopes, and the mineral species were determined by measuring their refractive indices by means of a series of liquids of known refraction.

SODIUM CARBONATE MINERALS OF THE MOGADI LAKES, BRITISH EAST AFRICA

P. Walther, *Newark Mineralogical Society*

Taking the train from Mombassa, the main port of British East Africa, to Nairobi, and traveling southwestward, one comes to the interesting Mogadi Lake. Tho called a lake, it is in reality only a deep valley filled with the sodium sesquicarbonate mineral, trona. During the rainy season water may collect there to a depth of about 30 cm., but wearing rubber boots one can cross the "lake" easily. In the dry season, which lasts more than three fourths of the year, the whole area, except at the extreme north end where a stream enters, is a porous mass of the crystalline mineral. This "lake" occupies a deep valley, running north and south, about 35 kilometers (22 miles) long but not more than 3 km. (2 miles) broad.

The Mogadi trona deposit consists of an aggregate of bladed columnar monoclinic crystals. Near the shore these reach a length of 8 or 9 cm., but further out they decrease to 5 cm. Their color is pale yellow, but on top there is often a crust of smaller crystals showing a brilliant red. The deposit shows alternating layers of large and small, and of clean and impure, crystalline material. An analysis of an average sample of specific gravity 2.14 gave: Na_2CO_3 43.55, $NaHCO_3$ 40.41, H_2O 15.55, NaCl 0.36, $Fe_2O_3+Al_2O_3$ 0.04, SiO_2 0.07, CaO, MgO and SO_3 traces, sum 99.98%. This establishes the formula as that of the sesquicarbonate mineral trona, $Na_2CO_3 . NaHCO_3 . 2H_2O$, and, as the other constituents are present for the most part in obvious mechanical admixture, the deposit is essentially a pure mass of this material.

The trona crystals are not affected by the atmosphere, but the red tint of the top layer bleaches out in sunlight. The colored constituent, which is present in very small amount, can be ex-

tracted from a solution of the red crust by shaking with ether. In the writer's opinion this red tint is due to admixture of the coloring matter from flamingo feathers. Large flocks of these birds can be seen in the northern end of the valley catching a small fish which, remarkable as it may seem, can live in the rather concentrated soda solution.

As to origin, it appears as if a sodium silicate rock must have been decomposed by the action of water and carbon dioxide. This is indicated, first, by the presence of extensive bands of flinty silica in the rocks near the "lake" and, further, by the escape of carbon dioxide from numerous cracks in the rocks. Had there been decomposition of sodium sulfate by limestone, for instance, there would be present large quantities of gypsum; or if the carbonate was magnesite, then epsomite would have been formed. There is, however, no gypsum or epsomite either in or near the "lake." If sodium sulfate had been decomposed by organic matter, such as fish, there would have been formed hydrogen sulfide, free sulfur or sulfide minerals, yet there is no trace of any of these in the district. Moreover, there is no evident source for the large body of original sodium sulfate which would be called for in such an explanation.

About 40 km. (25 miles) south of the Mogadi Lake lies the Little Mogadi. This is a shallow dry salt pan about 2 to 3 km. in diameter. The salt crusts found there are yellowish gray in color, and consist of bladed crystals also suggesting the monoclinic system. They are 2 to 3 cm. thick, and so hard as to emit when struck with a key a clear ringing sound. Analyses of two specimens collected there indicated the composition to be that of pure sodium bicarbonate, with only traces of organic impurities. It is commonly supposed, and specifically stated by Doelter in his Handbuch der Mineral Chemie, that sodium bicarbonate can not exist in nature, and that if it ever forms it changes promptly in contact with the air to trona, by the loss of part of its CO_2. However, it should be noted that the Little Mogadi is situated in the same depression as is the Mogadi Lake above described, and has probably been formed in some past geological time by an overflow from the larger "lake." The trona then deposited was exposed to the action of a large excess of carbon dioxide, which gas is continually being given off from the cracks in the soil and rock with a hissing sound. As a result, sodium bicarbonate could readily

form according to the reaction: $Na_2CO_3.NaHCO_3.2H_2O+CO_2=3NaHCO_3+H_2O$. The continued action of carbon dioxide would then prevent the decomposition of this compound back into trona.

The writer at first thought of naming sodium bicarbonate, here recognized as a mineral, after the locality. But on submitting a preliminary draft of this paper to Dr. Edgar T. Wherry, at that time Editor of THE AMERICAN MINERALOGIST, the latter recommended that no new name be given unless the nature of the material could be confirmed optically. Two small samples of the material collected were accordingly sent to Dr. Wherry; unfortunately they had been greatly delayed on the way from England to this country, and had become moist while standing for 6 weeks in the custom house. It was feared that they might be more or less decomposed. This proved to be the case, for Dr. Wherry reports as follows:

"It is easy to distinguish trona from sodium bicarbonate optically, for the latter has one refractive index as low as 1.380, practically matching the immersion liquid methyl-ethyl ketone, whereas trona has as its lowest index 1.410. The double refraction of the bicarbonate is also almost twice as great as that of the sesquicarbonate, so that they look somewhat different between crossed nicols. Moreover, the crystals of trona, being elongated on axis *b*, show parallel extinction. Sample 'B' consists of clear-cut blades a centimeter long, and has in every respect the typical optical characters of trona. Sample 'A,' on the other hand, is not uniform in structure. There are small crystalline rods, obviously of trona, scattered thru it, but also some minutely crystalline, efflorescent particles. I was unable to find in the latter material any crystals which had an index lower than the lowest of trona, but it is possible that it may represent a pseudomorph of trona after sodium bicarbonate. However, in view of the impossibility of obtaining definite optical data on the original unaltered material, it is urged that the introduction of a new mineral name for sodium bicarbonate be avoided for the present."

In conclusion, I wish to acknowledge the aid of Mr. Arthur Trowbridge of Felling on Tyne, Northumberland, England, the first European to visit the deposits, and obtain data on this interesting locality. Mr. Trowbridge's report as to the feasibility of commercializing these deposits has led to active operations for transforming the material into soda ash of high quality.

BOOK REVIEWS

PETROGRAPHIC METHODS AND CALCULATIONS. ARTHUR HOLMES. *New York:* D. Van Nostrand Co.; *London:* Thos. Murby & Co. 515 pages. 1921.

As we already have a comprehensive treatise with the title "Petrographic Methods," by Professor Albert Johannsen, the announcement of another book with the same leading title naturally led to some doubt as to the desirability of another volume covering the same subject. But a glance at a copy made it evident that the title is the only thing the two have in common, and that a real need is filled by the new book. The title is in neither case exactly descriptive of the contents; Johannsen's book is largely devoted to optical crystallography, while Holmes' is chiefly petrologic methods.

The first chapter deals with petrology, its scope, aims and application, the second with the specific gravity of minerals and rocks. In this chapter methods of determining specific gravity of large and small specimens are described in detail, with many helpful practical hints as to manipulation, sources of error, etc. But the discussion is not limited to methods; there are given also interesting data on formula volume and oxide volume relations of a number of rock making minerals.

The separation of minerals is then described at length, heavy solution, magnetic, electrostatic, and chemical methods of separation being covered, again with much practical detail. The optical examination of mineral fragments forms the subject of another chapter, and in this are included, beside many helpful suggestions as to procedure, some interesting charts of birefringence relations in minerals.

The examination of sediments and sedimentary rocks, which has not been adequately treated in any previous book in English, is next taken up, and its application to geologic investigations discussed. Not only are outlines of the most modern procedures and methods of interpretation included, but actual examples of many of them are presented.

The preparation of thin sections of rocks forms the subject of another chapter, followed by one on microchemical and staining methods which collects scattered literature references in a very useful way. For instance, no less than nine staining methods applicable to aragonite, calcite and dolomite, have been gathered. The examination of thin sections is also well described, and a good-sized chapter devoted to the textures and structures of igneous and metamorphic rocks.

Then there is a chapter on chemical analyses and their interpretation, which includes much data on minerals as well as on rocks; and a final one on graphic representation of chemical analyses. Every mineralogist should certainly become familiar with and apply the methods described in this last chapter, but will find numerous points of interest and value in most of the earlier ones as well.

W.

STUDY OF MINERALS AND ROCKS. AUSTIN F. ROGERS. Second edition. XVIII+527 pages with 578 text figures and one plate, 1921. McGraw-Hill Book Co., *New York.*

A distinct departure from the usual method of presenting the subject has been made in this revision of the author's Study of Minerals, which first appeared in 1912. The chapter on Chemical Properties of Minerals, with only a few minor changes, now appears as the first chapter in this edition. A short discussion of colloids and a few new blowpipe tests have been added.

The idea of hemihedrism has been completely dropped. Only eleven crystal classes are discussed in detail but a summarizing table of the thirty-two is given. The stereographic and gnomonic projections and the Stöber method of crystal drawing have been omitted but a brief discussion of the work of Laue and the Braggs has been added. It does not seem logical to present crystal measurement and drawing before taking up the crystal forms nor to use only the Miller indices in a text intended for beginners.

Dispersion, rotary polarization and optical anomalies have been dropped but the fundamental optical properties are more fully described. The descriptive portion now includes only 175 instead of 200 minerals. A distinct improvement has been made in the determinative tables, especially those based upon physical properties.

A reader will hardly see the justification of the new title "Study of Minerals and Rocks," as only a portion of a 45 page chapter on the Occurrence, Association and Origin of Minerals is devoted to the study of rocks.

C. B. S.

PROCEEDINGS OF SOCIETIES

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences, March 9, 1922

A stated meeting of the Philadelphia Mineralogical Society was held on the above date with the president, Mr. Trudell, in the chair. Fourteen members and one visitor were present.

Upon the recommendation of the executive council Messrs. Horace R. Blank and Bernard McQue were elected active members.

The program of the evening comprised an exhibition of the three best mineral specimens of each member. Notable exhibits were made by Messrs. Vaux, Frankenfield, Knabe, Boyle, Gordon, and Trudell.

Mr. Gordon described briefly a crystallographic study of wavellite from Bolivia, Pennsylvania, Arkansas, and Bohemia, with a number of new forms. Specimens were exhibited. A Nutting mercury vapor arc with blue, green, and yellow filters for the production of monochromatic light was shown.

Samuel G. Gordon, *Secretary.*

NEWARK MINERALOGICAL SOCIETY

The fiftieth regular meeting was called to order by President Walther, fifteen resident members and thirteen members from the New York Mineralogical Club were present; also one visitor.

The application of Miss Martha S. Thompson was received and referred to the proper committee. The secretary then passed around for inspection a design for a club pin and was instructed to procure 50, as per sample, for the members.

A motion was then made and carried that further business be dispensed with and to proceed with the paper for the day, which was on "Molybdenum and Its Ores," by Wm. H. Broadwell. Mr. O. I. Lee then followed with the "Chemistry of Molybdenum."

Mr. Broadwell had on exhibit 200 specimens of Australian ores; Mr. Walther, Mr. Reamer and Mr. T. I. Miller also exhibited many fine specimens.

Wm. H. Broadwell, *Secretary.*

NOTES AND NEWS

The American Geologist, which in 1905 was merged with Economic Geology, now appears in a new garb, The Pan-American Geologist. This monthly journal devoted to speculative geology, constructive geological criticism and geological record is edited by Charles Keyes, Des Moines, Iowa. The associated editors in this enterprise are Edward W. Berry, Baltimore, Md.; Eliot Blackwelder, Cambridge, Mass.; Henry S. Washington, Washington, D. C.; and Gilbert D. Harris, Ithaca, N. Y. The first issue, volume XXXVII, No. 1, appeared in February, 1922.

We regret to note the death of Dr. John Casper Branner, the distinguished geologist, after whom the mineral brannerite was named. Dr. Branner died on March 1 at the age of 71 years. At the time of his death he was president emeritus of Leland Stanford University.

Through the generosity of Miss Minns the Boston Society of Natural History has been able to install in its Museum a gem collection of precious and semi-precious stones found in New England. The collection at present is represented by 26 rough crystals and 151 cut gems and includes tourmaline, beryl, aquamarine, amethyst, topaz, beryllonite, quartz of various colors and phenacite.

Arrangements have been effected whereby the Optical Society of America, co-operating with the National Research Council and the Apparatus Makers Association, is to add to its journal a section on scientific instruments. The enlarged journal is to be published under the title *Journal of the Optical Society of America and Review of Scientific Instruments*, and will be issued monthly, beginning with May, 1922.

Professor Theodor Liebisch, late professor of mineralogy at the University of Berlin, died in Berlin on February 9, after a protracted illness. From 1890 to 1900 he was professor of mineralogy at the University of Göttingen. He then accepted the call to the University of Berlin and served there until 1920 when he retired from active work. He was the author of many books, his most important being "Grundriss der Physikalischen Krystallographie."

ABSTRACTS—MINERALOGY

AN INTERESTING OCCURRENCE OF SECONDARY RUTILE IN THE MILLSTONE GRIT. H. W. Greenwood. *Naturalist*, 1917, 244.

Minute crystals of rutile were found lining iron-stained cavities in the rock near Bollington. They appear to have been formed by the alteration of titaniferous biotite. Primary rutile is also present, and octahedrite was noted on leucoxene.

E. T. W.

METEORITES WHICH FELL AT BOGUSLAVKA, 220 KILOMETERS NORTH OF VLADIVOSTOCK. Helge Backlund. *Geol. Fören. Förh.*, 39, 105, 1917. [Swedish.]

On October 18, 1916, at 11.47 A.M. two iron meteorites fell 6 km. north of Boguslavka, weighing respectively 199 and 57 kg. They are now in the geological museum in Petrograd. These are the largest iron meteorites ever seen to fall, and in fact only the 11th instance of irons seen. They are cubic kamacites, without

Widmanstätten figures, resembling the Braunau iron in this and in the nickel content, which is slightly over 5% in both. E. T. W.

RECENT INVESTIGATIONS ON HARDNESS. A. ROSIWAL. *Mitt. Wiener Min. Ges.* **1917**, No. 80, 69–70; thru *Neues Jahrb. Min. Geol.* **1919**, Ref. 125–126. The measure of hardness is taken as the number of meter-kilograms of work necessary to grind away 1 cu. cm. of the mineral tested. The grinding was done under standardized conditions in every case. Values obtained were:—corundum, (aver.) 45,000; topaz (110) 6,280; quartz (0001) 5,250; orthoclase ⊥ (001) and (010) 2,000; (010) 1,395; (001) 947; apatite (10$\bar{1}$0) 322; calcite (aver.) 202; halite (111) 109; talc 49.6. EDW. F. HOLDEN.

AN APPARATUS FOR MEASURING COLOR. A. v. HÜBL. *Phys. Z.* **18**, 270–275, 1917; thru *Neues Jahrb. Min. Geol.*, **1919**, Ref. 127. Three color filters give red, green, and blue light, the intensity of which may be varied. The object whose color is to be measured is compared to the color resulting from combinations of these filters. E. F. H.

FOUR COMPONENT SYSTEMS. H. E. BOEKE. *Z. anorg. allg. Chem.* **98**, 203–222, 1916; thru *Neues Jahrb. Min. Geol.* **1918**, Ref. 122–123. The author discusses the possibilities of composition in a cooling four-component melt.

E. F. H.

THE HARDNESS OF METALLIC ALLOYS. P. LUDWICK. *Z. anorg. allg. Chem.* **94**, 161–192, 1916; thru *Neues Jahrb. Min. Geol.* **1918**, Ref. 11.

The hardness of many alloys was determined, both when they had been chilled and when annealed. Relations between hardness and atomic concentration were not observed. E. F. H.

THE CHANGE, CAUSED BY ISOMORPHOUS MIXTURES, IN THE ANGLE (001)∧(010) OF PLAGIOCLASE. F. RINNE. *Centr. Min. Geol.* **1916**, 361–363.

It is shown that the straight line relation between chemical composition and the value of the angle (001) ∧ (010) in the plagioclases does not hold at other than ordinary temperatures, but is represented by a curved line, as with other angles at room temperatures. E. F. H.

THE ABSOLUTE SYSTEM OF COLORS. W. OSTWALD. *Z. phys. Chem.*, **12**, 129–142, 1916; thru *Neues Min. Geol.*, **1917**, Ref. 1–2.

Ostwald classifies colors upon the three-fold basis of hue, purity, and brightness. This system may be applied in the description of mineral colors.

E. F. H.

SIMPLE GLIDING IN TIN AND ITS CHANGE OF CONDITION AT 161°. O. MÜGGE. *Centr. Min. Geol.* **1917**, 233–239.

A study of the behavior of the twinning lamellae of tin. When heated to its melting point the form stable above 161° is crystallographically very similar to that of tetragonal tin of ordinary temperatures. E. F. H.

INVESTIGATIONS OF A ZONALLY COLORED TOURMALINE CRYSTAL. HERM. TERTSCH. *Centr. Min. Geol.* **1917**, 273–289.

This paper is a study of the development of the faces during the growth of a tourmaline crystal as revealed by the form of the differently colored zones.

E. F. H.

CALCITE CRYSTALS WITH CURVED FACES. G. AMINOFF. *Geol. Fören. Förh.*, **39**, 664–670, 1917. [Swedish.]

A specimen of crystallized calcite from Clausthal is remarkable in showing large faces of a rhombohedron near $(0.13.\overline{13}.8)$, with greatly curved faces. Previous work on crystals with curved faces, made possible by the introduction of the 2-circle goniometer, is reviewed. The features shown by these faces and their reflections indicate them to be transition faces. E. T. W.

THE SIMPLEST PATHS OF THE ATOMS DURING GLIDING IN HEMATITE AND CORUNDUM. A. JOHNSEN. *Centr. Min. Geol.* **1917**, 433–445.

The paths of the atoms in gliding along (100) and (111) are described. E. F. H.

ARTIFICIAL GLIDING IN RUTILE. A. GRÜHN and A. JOHNSEN. *Centr. Min. Geol.* **1917**, 366–374.

Rutile crystals were packed in sulfur powder, and under a pressure of 10,000 to 30,000 atm. gliding along (101) was produced. A comparison of this and the natural gliding in rutile is given. E. F. H.

NEW MINERAL OCCURRENCES IN THE STEIERMARK. ALOIS SIGMUND. *Mitt. Naturw. Ver. Steiermark* **53**, 245–246, 1916/17; thru *Neues Jahrb. Min. Geol.* **1919**, Ref. 32.

Occurrences of limonite and hematite from Frohnleiten; cobalt minerals from the Neualpe Schladming; and contact twins of cerussite, twinning plane (110), in a muscovite schist from Kaltenegg, Vorau. E. F. H.

THE OCCURRENCE OF THE RARE MINERAL MONAZITE IN THE MILLSTONE GRIT OF YORKSHIRE. A. GILLIGAN. *Naturalist*, **1917**, 87–88.

In a garnetiferous layer of rock at Cragg Hill quarries, Horsforth, grains of rutile, zircon, tourmaline, and monazite were discovered. The last was identified by its absorption spectrum. It was subsequently found at several other localities. E. T. W.

STUDIES ON GYPSUM TWINS FROM THE NEOCOMIAN CLAYS OF THE VICINITY OF BRAUNSCHWEIG. E. STOLLEY. *10. Jahresber. Niedersächs geol. Ver., Hannover, Geol. Abteil. Naturhist. Ges. Hannover* **1917**; thru *Neues Jahrb. Min. Geol.* **1919**, Ref. 149–150.

Crystals from several localities show contact twins with the twinning plane either (100) or (101). They contain a large amount of clay and limonite inclusions. E. F. H.

A NEW OCCURRENCE OF KIESERITE CRYSTALS. H. GRANDINGER. *Centr. Min. Geol.* **1917**, 49–51.

Four new forms, w (011), m (010), z $(\overline{1}12)$ and s $(\overline{7}74)$ were found on clear white crystals of kieserite from Hildesheim. E. F. H.

THE CHANGE IN THE CRYSTAL ANGLES OF RELATED SUBSTANCES, CAUSED BY INCREASE IN TEMPERATURE. II. F. RINNE AND R. GROSSMAN. *Centr. Min. Geol.* **1917**, 73–82.

On heating to 500° diopside and hornblende show similar changes in the crystal angles and axial ratios. For diopside from the Piedmont; at 20° $a:b:c=1.09213:1:0.58931$, $\beta=74°10'9''$; at 500° $a:b:c=1.08762:1:0.58604$, $\beta=74°3'57''$: for hornblende from Monte Somma; at 17° $a:b:c=0.54826:1:0.29377$, $\beta=73°58'12''$; at 500° $a:b:c=0.54766:1:0.29333$, $\beta=73°52'38''$. E. F. H.

INTERGROWN CARLSBAD TWINS OF SANIDINE FROM LAACHER SEE. R. BRAUNS. *Neues Jahrb. Min. Geol.* **1917**, 45–49.

Small transparent sanidine crystals occur in druses in cavities of an altered alkali syenite. Besides parallel groupings of the crystals, there are interpenetrating Carlsbad twins, in which *y* is greatly developed. The feldspar is probably of pneumatolytic origin. E. F. H.

PREHNITE FROM ADAMS SOUND, ADMIRALTY INLET, BAFFIN'S ISLAND, FRANKLIN. H. SIMMERSBACH. *Z. prakt. Geol.* **25**, 1917, 139–141; thru *Neues Jahrb. Min. Geol.* **1919**, Ref. 276–277.

A prehnite high in iron ($Fe_2O_3=6.58\%$) occurs in calcite-quartz veins with galenite and pyrite. Sp. gr. = 2.924. E. F. H.

THE CAUSE OF THE STEEL-LIKE LUSTER OF ILVAITE. O. MÜGGE. *Centr. Min. Geol.* **1917**, 82–84.

Thin films of goethite, resulting from alteration of the ilvaite, give it this luster. E. F. H.

CONTRIBUTION TO THE MINERALOGY OF COLOMBIA. MAX BAUER, *Centr. Min. Geol.* **1916**, 481-487.

This paper is a review of a work published in 1915, "Contribucion al Estudio de los Minerales de Colombia" by R. L. Codazzio of the Univ. of Bogota. Descriptions are given of the emerald deposit of Muzo; of large pseudomorphs of chromite after garnet, with pitch-blende, tourmaline, mica and orthoclase in a contact zone between pegmatite and gneiss at Arboledas; and of concretions in the sandstone of Bogota, containing at different localities wavellite of several varieties, vivianite, ludlamite, and dufrenite. E. F. H.

PRECIOUS STONES IN THE URALS. C. W. PURINGTON. *Mining Mag.* **15**, 24-5, 1916; thru *Min. Abst.* **1**, 131, 1921.

This paper describes the emerald mines of the Great Rift River, and the mineral occurrences in the Ilmen Mts. and near Zlatooust. E. F. H.

CHEMICAL ANALYSIS OF PICKERINGITE FROM OPÁLBÁNYA. V. ZSIVNY. *Ann. Hist.-Nat. Musei Nationalis Hungarici* **14**, 454-6, 1916; thru *Min. Abst.* **1**, 212, 1921.

In this pickeringite, $[Al_2Mg(SO_4)_4 . 22\ H_2O]$, 4.04% Fe_2O_3 replaces some alumina, and a little MgO is replaced by FeO and CaO. E. F. H.